

Biodiesel and Renewable Diesel Workgroup

California Biodiesel Multimedia Evaluation Tier I Report

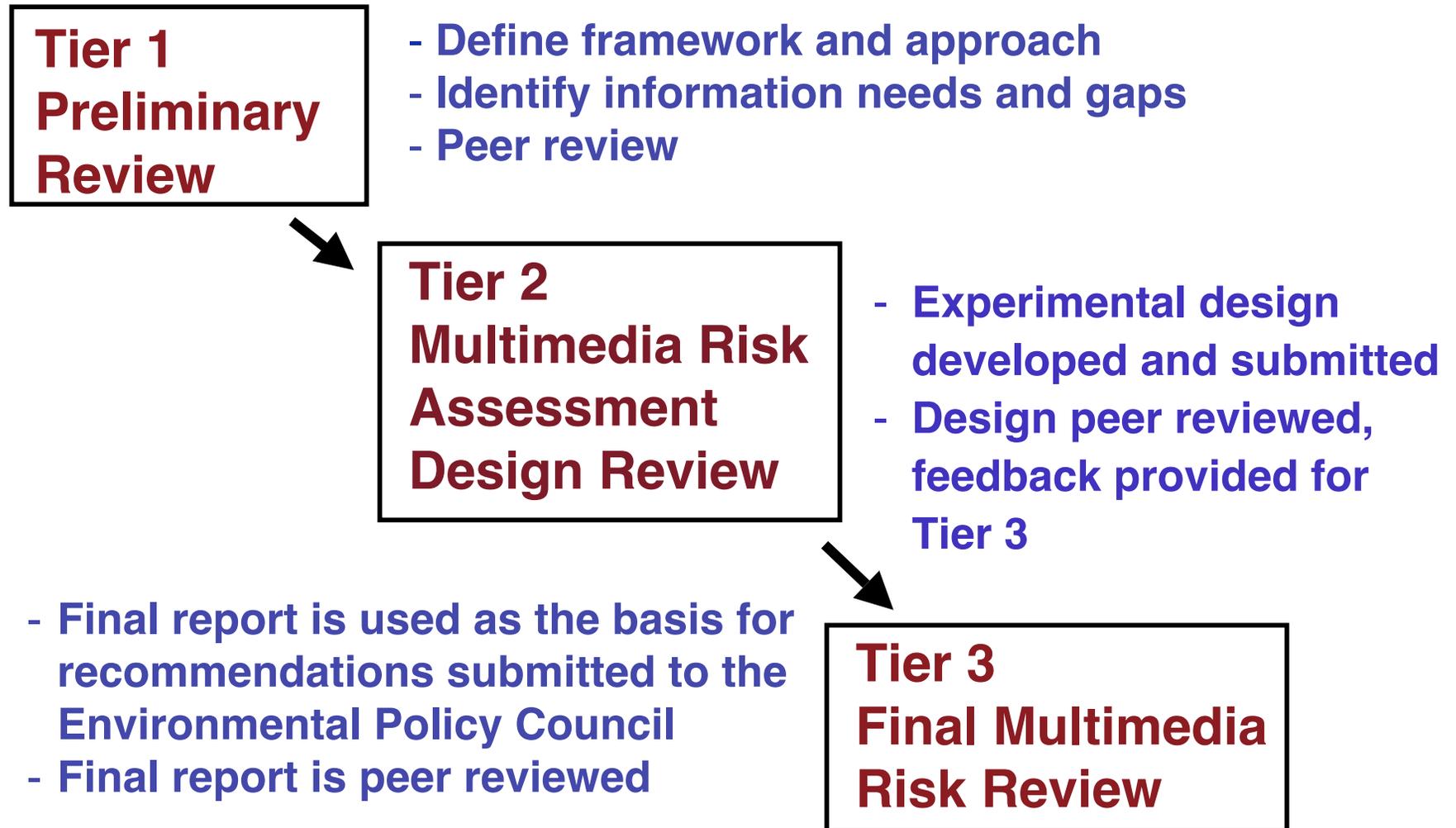
**March 12, 2009
Sacramento, CA**

Tom McKone, University of California, Berkeley

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Tiered Approach Refresher



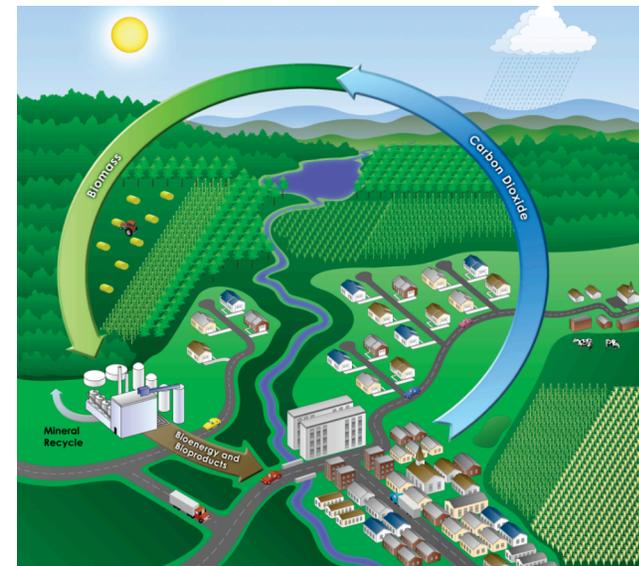
Overview of the Biodiesel Tier I Report

- **Biodiesel Background Information**
- **Biodiesel Life Cycle**
 - Biodiesel Feedstock Collection/Production
 - Production of Biodiesel
 - Storage and Distribution of Biodiesel
 - Use of Biodiesel
- **Release Scenarios**
- **Environmental Transport and Fate of Biodiesel**
- **Biodiesel Toxicity**
- **Biodiesel Life Cycle Impacts**
- **Conclusions about Key Information Gaps**



Biodiesel Background

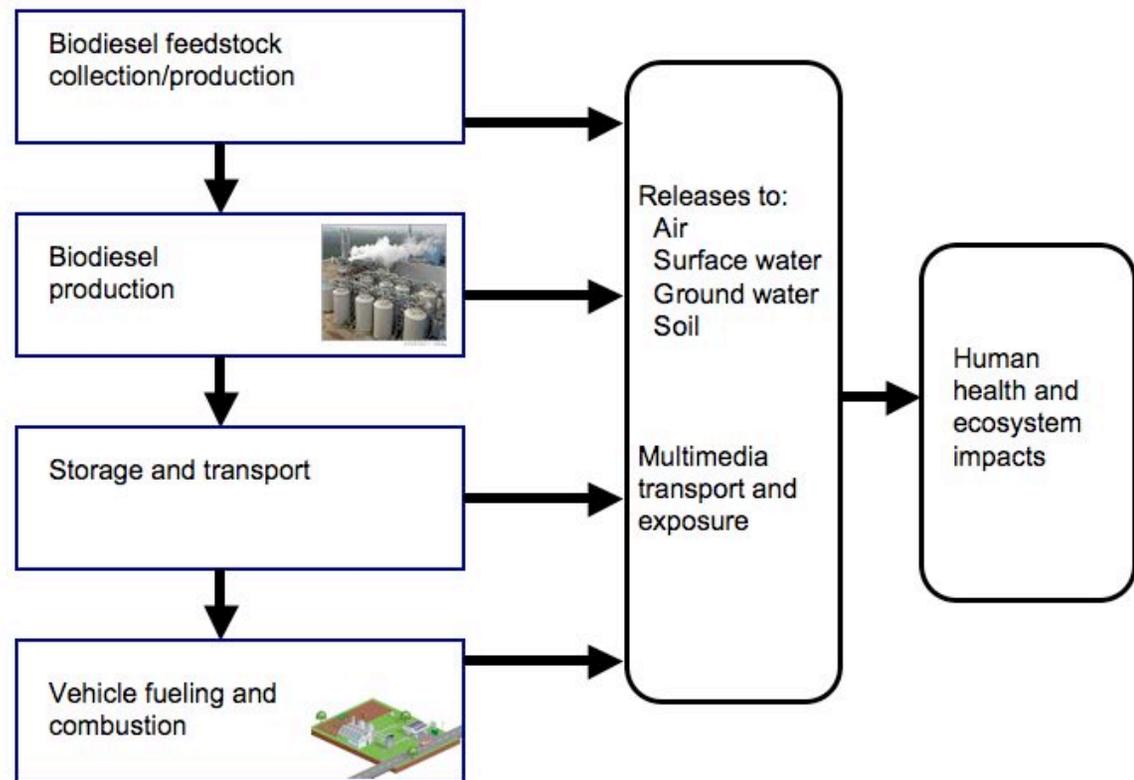
- **Biodiesel is composed of mono-alkyl esters of long chain fatty acids derived from:**
 - a broad range of vegetable/seed oils
 - recycled cooking greases or oils
 - animal fats
 - algal oils
- **Biodiesel can be used as a pure fuel or as a blend with petroleum diesel**
- **Our focus is on a blend of 20% biodiesel with 80% standard ULSD (B20) and on 100% biodiesel (B100), partial evaluation of B5**
- **A key goal of encouraging fuels such as biodiesel is to reduce California's carbon "footprint"**



Courtesy of C. Somerville, UC Berkeley

Biodiesel Life Cycle

- Biodiesel Feedstock Collection/Production
- Production of Biodiesel
- Storage and Distribution
- Use of Biodiesel



Biodiesel Feedstock Collection/Production

- **Primary biodiesel feedstocks expected to be used in California include:**

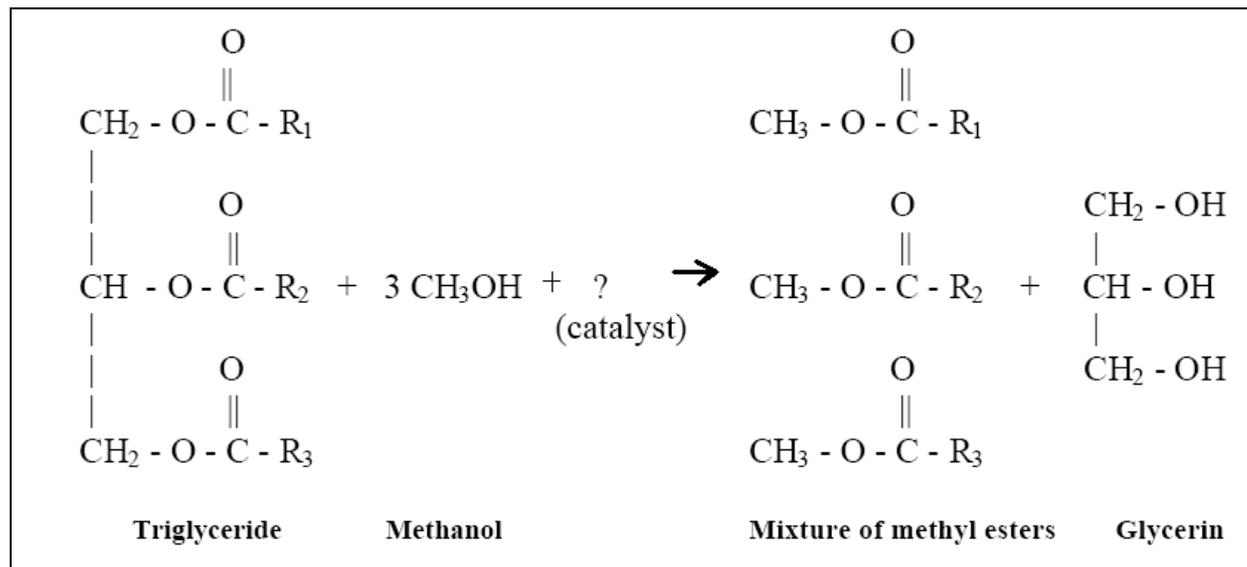
- soybean oil
- animal tallow
- yellow grease
- canola
- safflower
- palm oil
- algae
- trap (brown) grease



- **Biodiesel feedstocks are classified by their fatty acid profile**
- **Price, availability, origin, geography, and consistent quality generally dictate which feedstock biodiesel producers use**

Production of Biodiesel

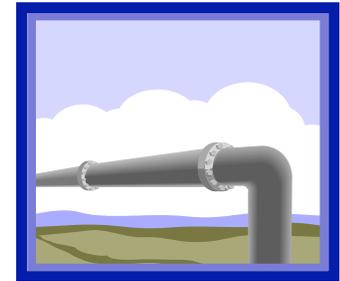
- To make biodiesel, a vegetable oil or fat is subjected to a chemical reaction known as transesterification



- Air emissions and hazardous wastes are important considerations for production operations

Storage and Distribution

- **Material compatibility is important to consider during the storage and distribution of biodiesel**
- **Biodiesel is susceptible to chemical changes during long-term storage**
- **Chemical additives to address**
 - oxidative stability
 - microbial contamination
 - increased water affinity
 - cold-flow properties
 - increased NOx emissions of biodiesel
- **Routine emissions and “off-normal” events (pipe-breaks, large spills) must be addressed**



Use of Biodiesel

- In the fuel-use stage, the releases of greatest concern are emissions to air
- But there are also potential releases to water and soil
- Several studies have determined biodiesel blends exhibit reductions in hydrocarbons (HC), particulate matter (PM) and carbon monoxide (CO) emissions
- There are also vehicle operability issues with biodiesel blends:
 - cold fuel flow
 - fuel foaming
 - water separation
 - fuel oxidative stability

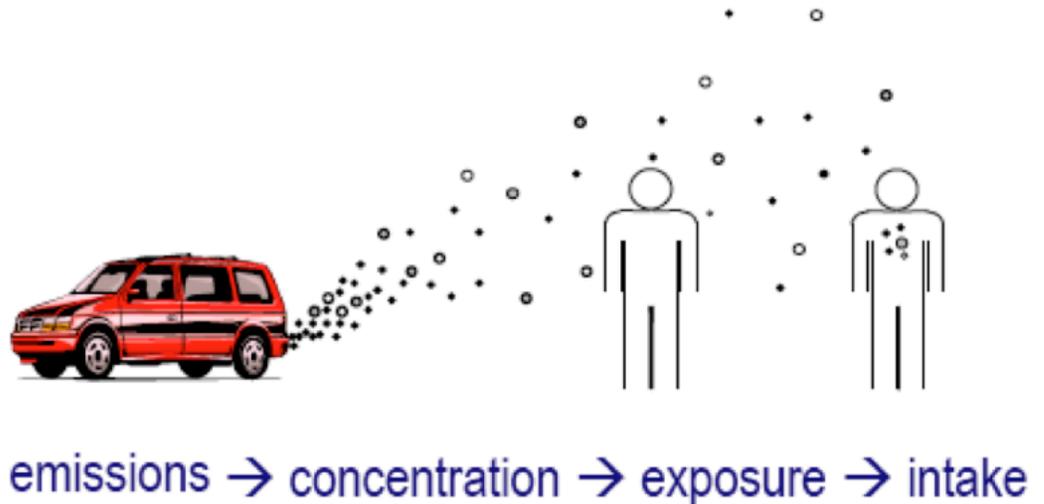


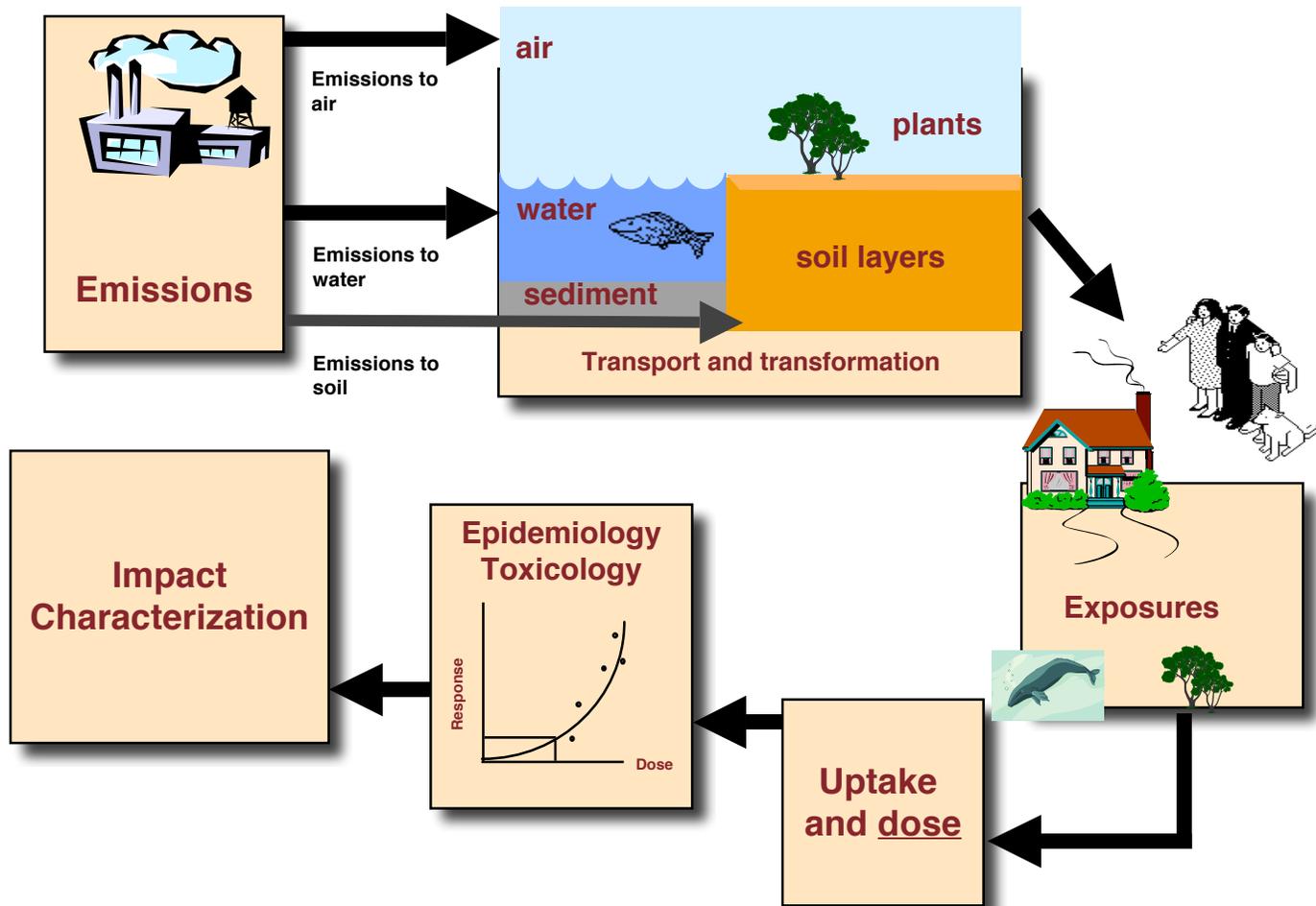
Figure from Julian Marshall University of Minnesota

Defining Release Scenarios

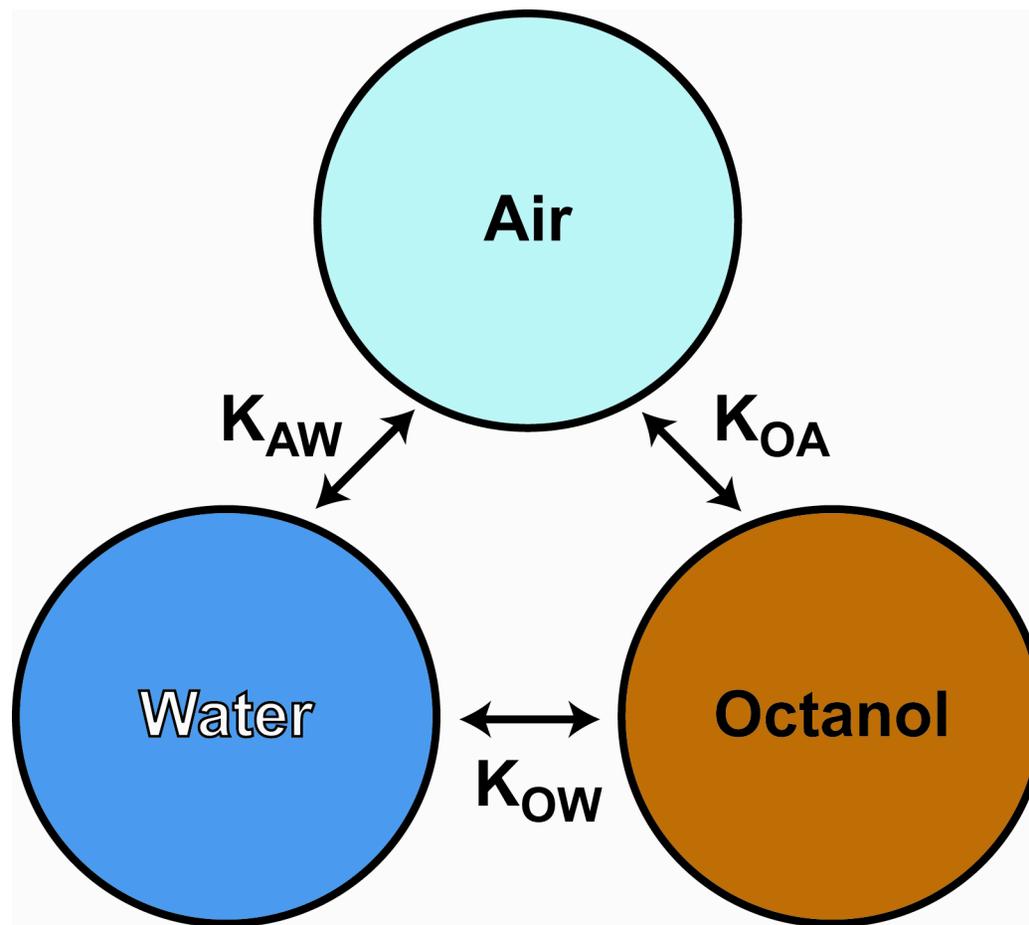
- **Selection of biodiesel feedstock**
- **Selection of additives mix**
- **Identify normal (routine) releases during production for example**
 - **Hexane or CO₂ released to the air during seed extraction.**
 - **Odors associated with waste biomass**
 - **Methanol releases to air or water**
 - **Used process water discharges of various pH and trace-chemical composition**
- **Normal releases during use include tailpipe emissions, both to air and to surface waters (marine vehicles)**
- **Identify off-normal releases, such as leak or rupture of:**
 - **an above-or below-ground storage tank and associated piping,**
 - **rail tank car, tanker truck, or tanker ship.**
 - **bulk fuel transport pipeline**



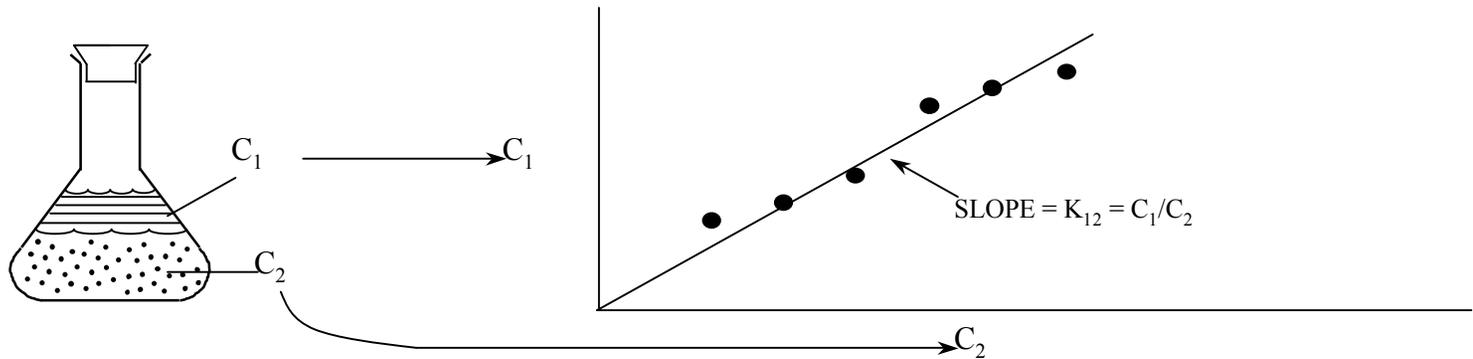
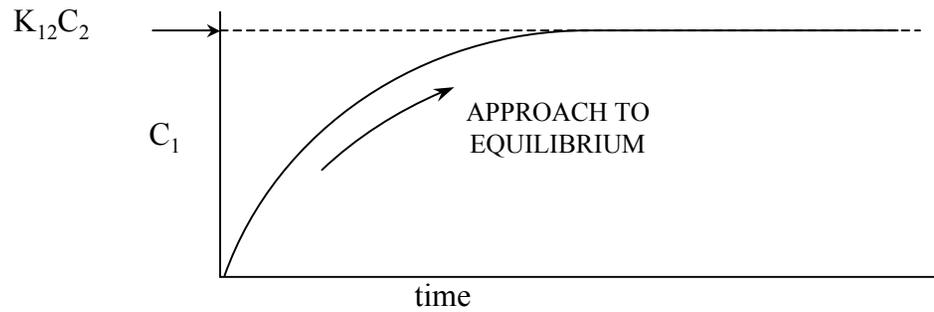
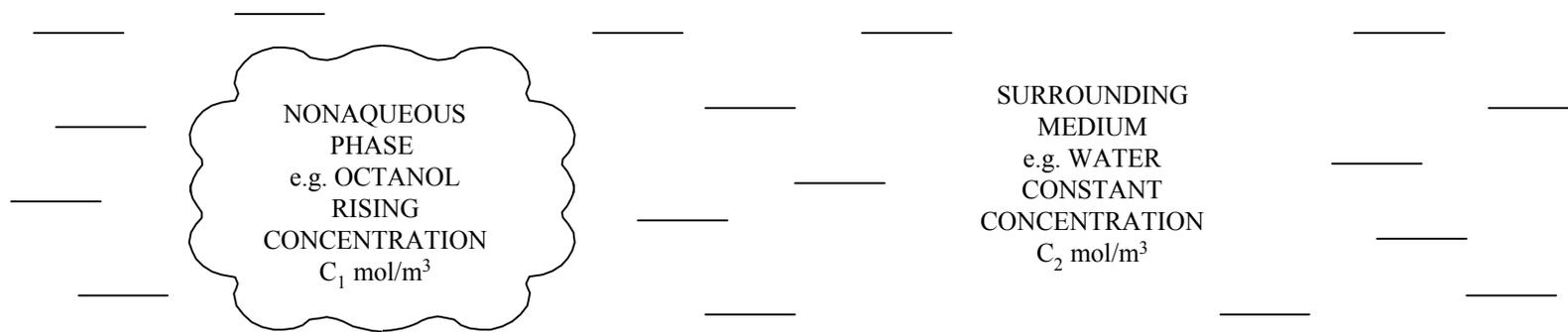
Environmental Transport and Fate



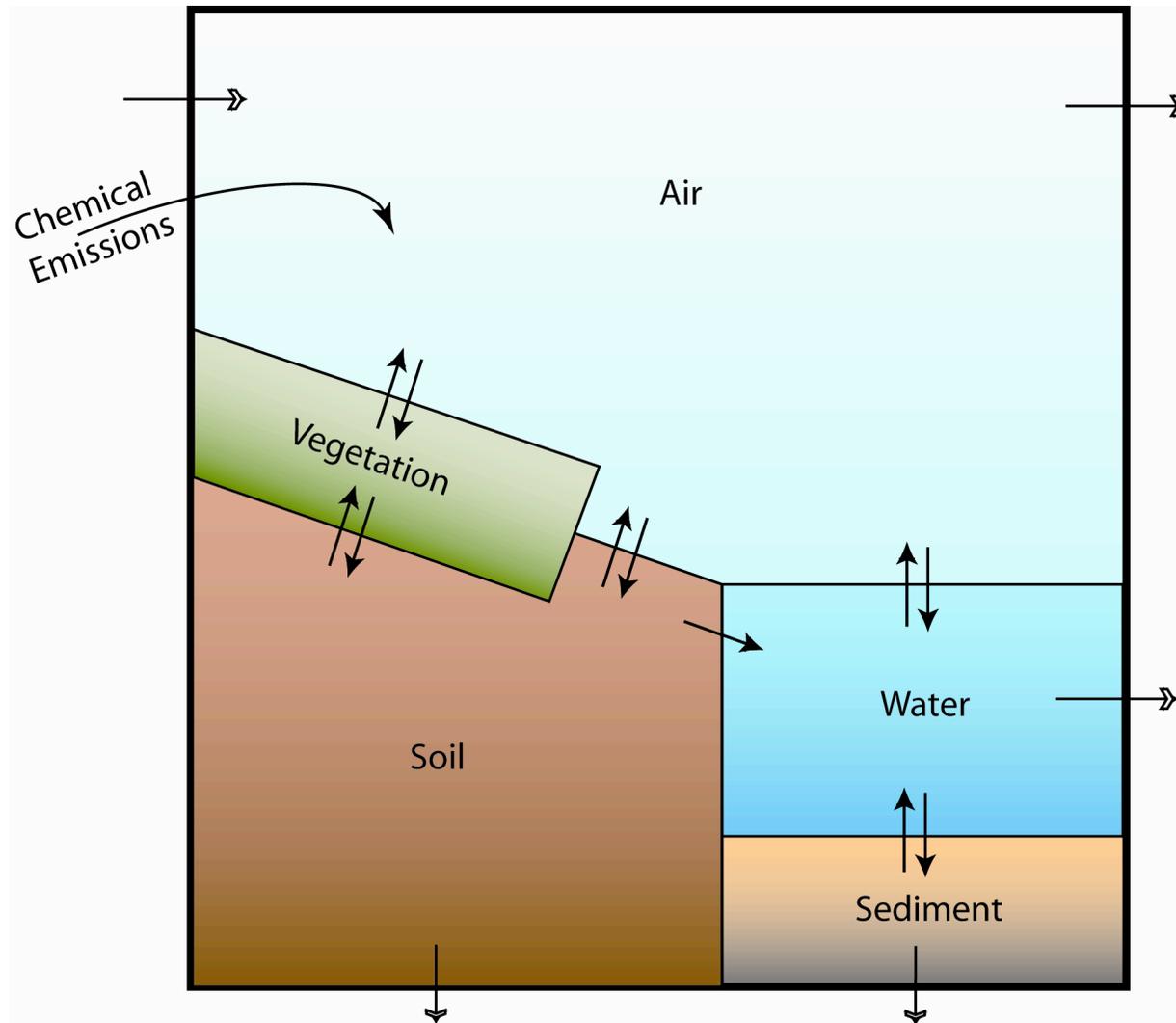
The long-term behavior chemicals in the environment is determined by their partitioning between three primary media:



Experimental Determination of Partition Coefficients



Level II multimedia contaminant fate model



Biodiesel Toxicity

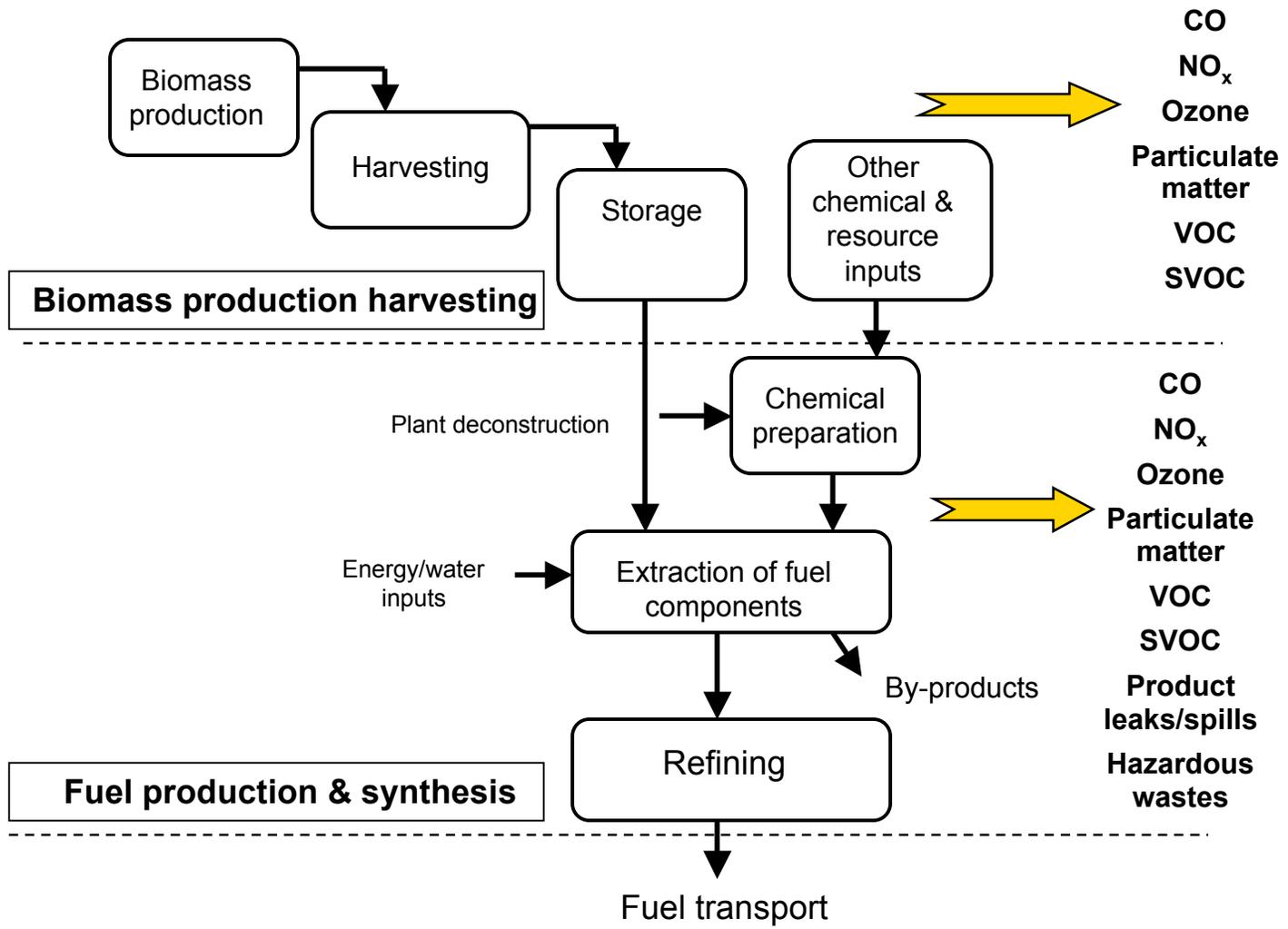
- **Human and ecological risk**
 - Hazard identification
 - Toxicity (dose-response)
 - Potential for exposure
 - Sensitive populations
- **Toxic air pollutants**
- **Toxicity assessment to fill data gaps**

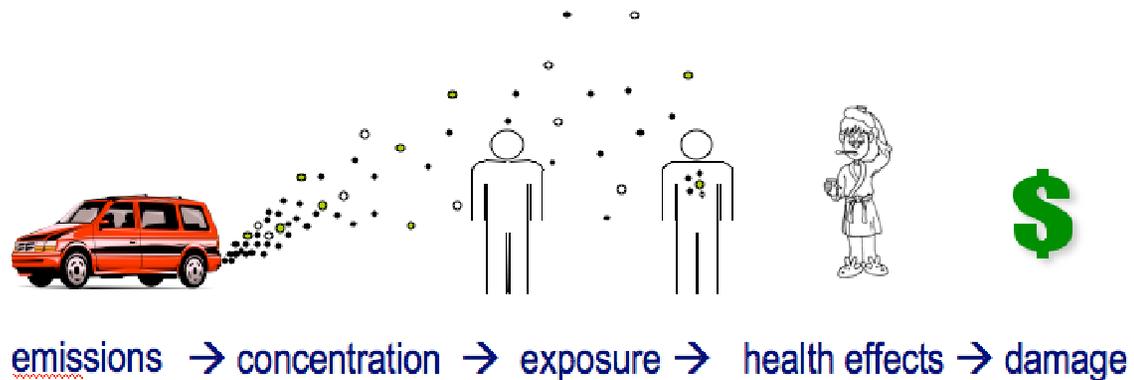
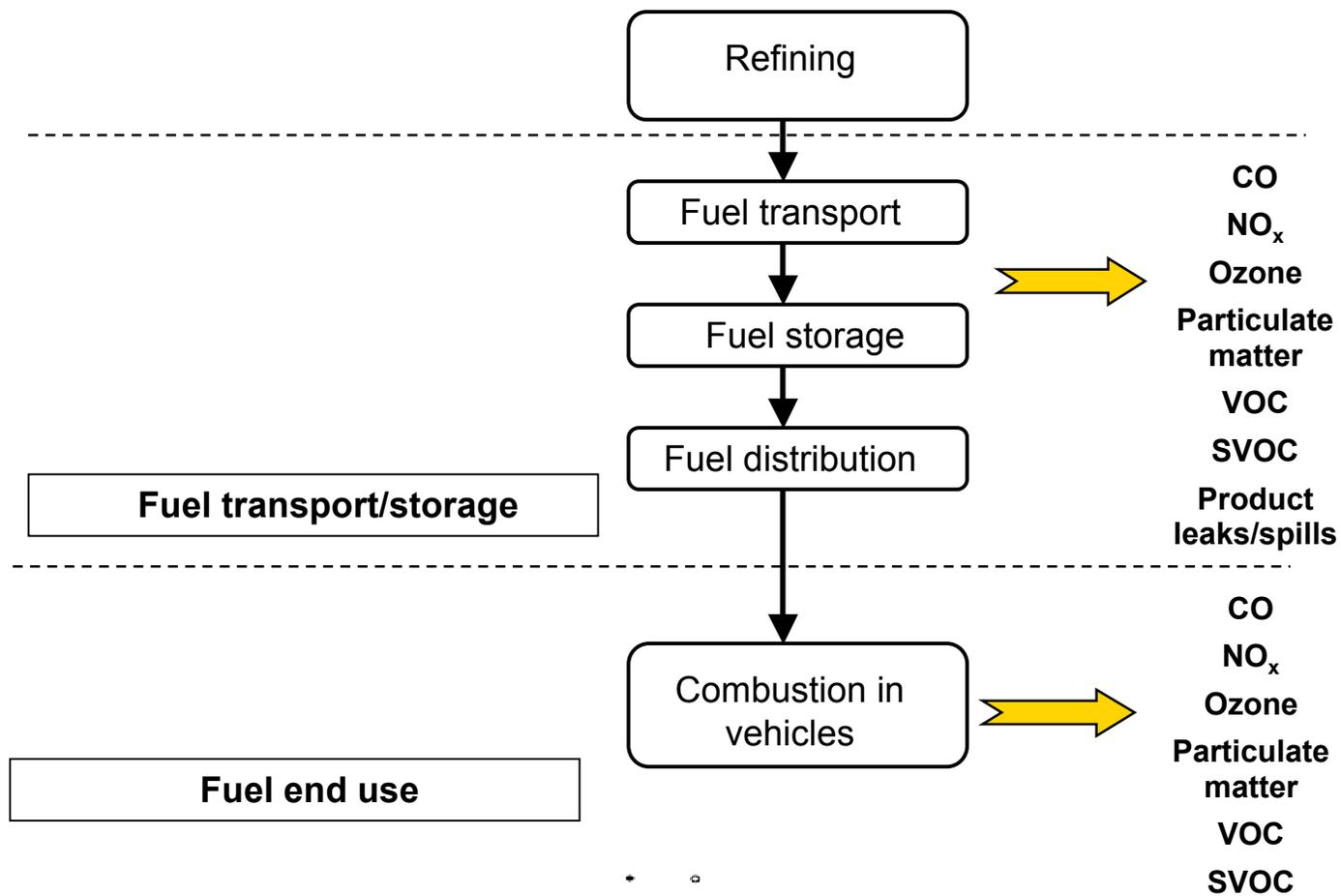


Biodiesel Life-Cycle Impacts

- **Life-Cycle Approach**
 - **Biomass production and harvesting or feedstock collection**
 - **Fuel production**
 - **Fuel transport and distribution**
 - **Fuel combustion**
- **Pollutant releases at each life stage**
- **Transport and fate**
- **Exposure and dose**
- **Toxicology and risk**





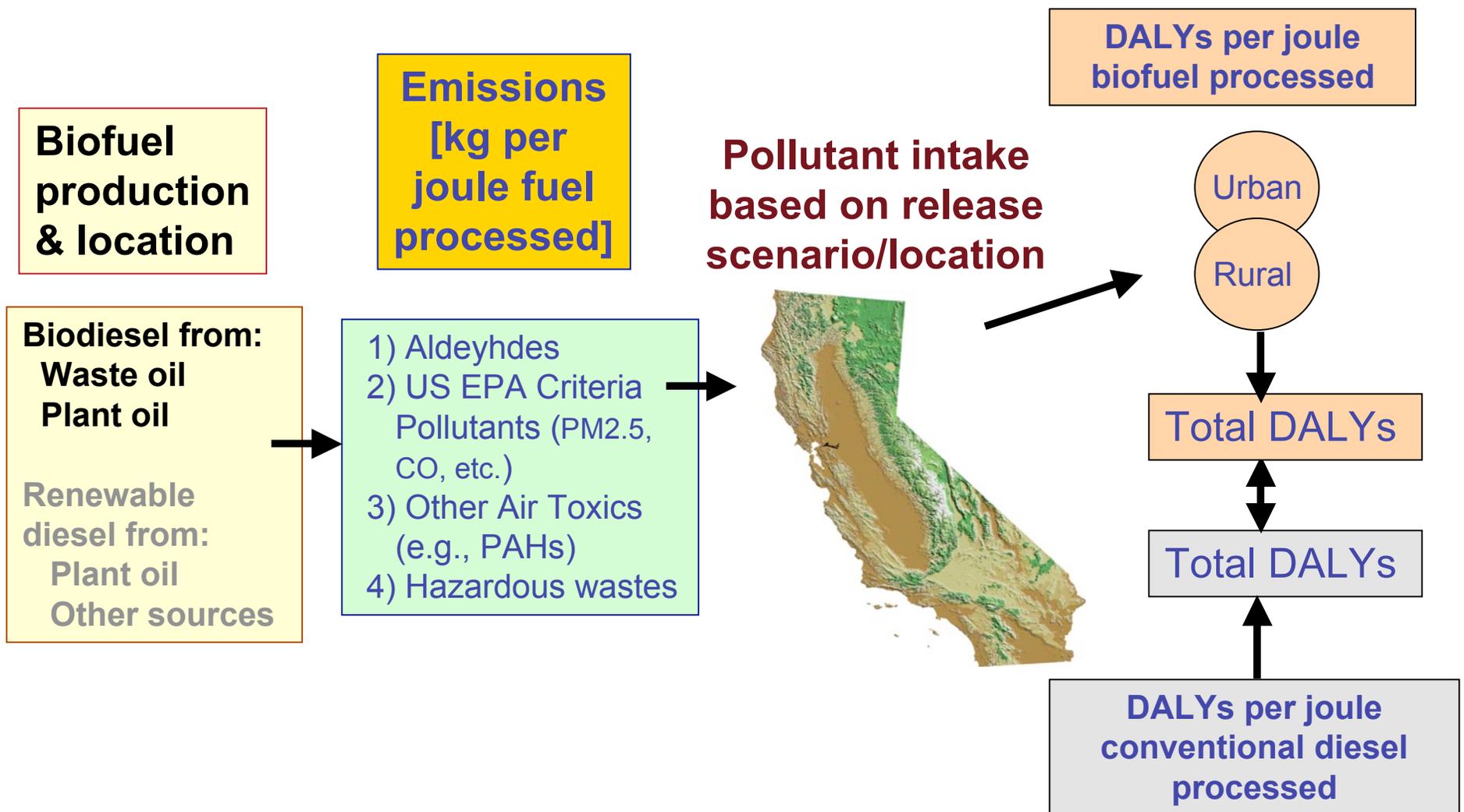


Graphic courtesy of
Julian Marshall
University of Minnesota

Life Cycle Impact

Disability adjusted life years (DALYs)

Potential disease burden



Conclusions About Key Information Gaps

- **Additives composition, use, and impact**
 - How biocides and anti-oxidants impact biodegradation
 - How priority additive impact human and ecosystem health
 - How cold flow property controllers impact multiphase transport
 - *toxicity*
- **Subsurface fate and transport properties**
- **Releases - Material Compatibility**
- **Biodegradation of all biodiesel components in soils and aquifers**
- **More information on air emissions**
- **Missing toxicological data**

